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MATHEMATICS.—*Transformations associated with the Lorentz group.*[1] CHARLES BARAFF, U. S. Patent Office. (Communicated by L. H. ADAMS.)

Einstein's special relativity theory transformation[2] is:

$$\left.\begin{aligned} x_1 &= \beta\,(x - vt) \\ y_1 &= y \\ z_1 &= z \\ t_1 &= \beta\left(t - \frac{vx}{c^2}\right) \end{aligned}\right\} \quad (1)$$

$$\text{where } \beta = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Another form of this transformation is:

$$\left.\begin{aligned} x_1 &= x\cos\theta + ict\sin\theta \\ y_1 &= y \\ z_1 &= z \\ t_1 &= t\cos\theta + \frac{xi}{c}\sin\theta \end{aligned}\right\} \quad (2)$$

where $\theta = \tan^{-1}\frac{vi}{c}$ and c = constant velocity of light. Minkowski[3] calls this form the special Lorentz transformation group.

[1] Received January 16, 1926.
[2] EINSTEIN, A. Annalen d. Physik 17: 891. 1905.
[3] MINKOWSKI, H. *Grundgleichungen für die elektro-magnetische Vorgänge*, p. 10.

Still another equivalent form is:

$$\left.\begin{aligned} x_1^2 - c^2t_1^2 &= x^2 - c^2t^2 \\ y_1 &= y \\ z_1 &= z \\ x_1 - ct_1 &= e^{-i\theta}\ (x - ct) \\ \text{where } \theta &= \tan^{-1}\frac{vi}{c} = \cos^{-1}\beta \end{aligned}\right\} \quad (3)$$

The above equations represent the finite transformations of the special relativity theory. They may be derived by integrating the differential equations

$$\frac{dx_1}{ct_1} = \frac{c\ dt_1}{x_1} = \frac{dy_1}{0} = \frac{dz_1}{0} = id\theta \quad (4)$$

the initial conditions being that when θ or $v = 0$ then

$$x_1 = x$$
$$y_1 = y$$
$$z_1 = z$$
$$t_1 = t$$

The most general function of the space time coördinates that remains invariant to the special relativity transformation is derived from the integration of the partial differential equation:

$$ct\frac{\partial f}{\partial x} + \frac{x}{c}\frac{\partial f}{\partial t} = 0$$

the solution of which is

$$f\ (x^2 - c^2t^2,\ y,\ z)$$

If set equal to zero, to wit, $f = 0$ represents the most general space time configuration that is unaffected or invariant to a special relativity transformation. This is a three dimensional surface in a four dimensional space time universe.

The physical interpretation of invariants in this paper is that they are quantities or the relations of quantities which appear alike to a stationary observer and to an observer moving uniformly relative to the stationary observer. They are relations which have the same form both in a stationary system and in a moving system.

II

The special relativity transformations of velocities are:

$$\left.\begin{aligned} u_x' &= \frac{u_x - v}{1 - \frac{vu_x}{c^2}} \qquad u_y' = \frac{u_y}{\beta\left(1 - \frac{vu_x}{c^2}\right)} \\ u_z' &= \frac{u_z}{\beta\left(1 - \frac{vu_x}{c^2}\right)} \end{aligned}\right\} \quad (5)$$

Their derivation follows easily from the Lorentz form, for differentiating,

$$\begin{aligned} dx_1 &= dx \cos\theta + ic\, dt \sin\theta \\ dy_1 &= dy \\ dz_1 &= dz \\ dt_1 &= dt \cos\theta + \frac{dx\, i}{c} \sin\theta \end{aligned}$$

Dividing dx_1 by dt_1

$$\frac{dx_1}{dt_1} = \frac{\frac{dx}{dt} + ic \tan\theta}{1 + \frac{i}{c} \tan\theta \frac{dx}{dt}} = \frac{u_x - v}{1 - \frac{vu_x}{c^2}}$$

Similarly:

$$\frac{dy_1}{dt_1} = \frac{\frac{dy}{dt}}{\cos\theta\left(1 + \frac{i}{c} \tan\theta \frac{dx}{dt}\right)} = \frac{u_y}{\beta\left(1 - \frac{vu_x}{c^2}\right)}$$

$$\frac{dz_1}{dt_1} = \frac{u_z}{\beta\left(1 - \frac{vu_x}{c^2}\right)}$$

This is the same result as that obtained by Einstein[4] from the consideration of the invariance of the Maxwell equations toward the

[4] EINSTEIN, A. Jahrbuch d. Radioaktivität und Elektronik, 1907 p. 411.

special relativity transformation. Here the components of velocity were the u_x, u_y, u_z in the equations:

$$\left.\begin{aligned} \frac{\partial N}{\partial y} - \frac{\partial M}{\partial z} &= \frac{1}{c}\left(\rho u_x + \frac{\partial X}{\partial t}\right) \\ \frac{\partial L}{\partial z} - \frac{\partial N}{\partial x} &= \frac{1}{c}\left(\rho u_y + \frac{\partial Y}{\partial t}\right) \\ \frac{\partial M}{\partial x} - \frac{\partial L}{\partial y} &= \frac{1}{c}\left(\rho u_z + \frac{\partial Z}{\partial t}\right) \end{aligned}\right\} \quad (6)$$

By means of the special relativity transformation, this equation, which is one of Maxwell's four fundamental equations, passes over into the equation

$$\left.\begin{aligned} \frac{1}{c}\left(\rho' u_x' + \frac{\partial X'}{\partial t'}\right) &= \frac{\partial N'}{\partial y} - \frac{\partial M'}{\partial z} \\ \frac{1}{c}\left(\rho' u_y' + \frac{\partial Y'}{\partial t'}\right) &= \frac{\partial L'}{\partial z'} - \frac{\partial N'}{\partial x'} \\ \frac{1}{c}\left(\rho' u_z' + \frac{\partial Z'}{\partial t'}\right) &= \frac{\partial M'}{\partial x'} - \frac{\partial L'}{\partial y'} \end{aligned}\right\} \quad (7)$$

where u_x' u_y' u_z' have the values in terms of u_x u_y u_z given in Equation (5).

It should be noted that the transformation equations for velocities also form a group of one-parameter transformations. They may be derived from the differential equations

$$\frac{u_x'\,\mathrm{d}u_x'}{c\left(1 - \frac{u_x'^2}{c^2}\right)} = \frac{c\,\mathrm{d}u_y'}{-u_y} = \frac{c\,\mathrm{d}u_z'}{-u_z'} = i\,\mathrm{d}\theta\,u_x'$$

by integration, with the initial conditions that when

$$\theta \text{ or } v = 0$$

then

$$u_x' = u_x$$

$$u_y' = u_y$$

$$u_z' = u_z$$

The most general distribution of velocities that remain invariant to the special relativity transformation are determined by the partial differential equations:

$$ct\frac{\partial f}{\partial x} + \frac{x}{c}\frac{\partial f}{\partial t} + c\left(1 - \frac{u_x^2}{c^2}\right)\frac{\partial f}{\partial u_x} = 0$$

$$ct\frac{\partial f}{\partial x} + \frac{x}{c}\frac{\partial f}{\partial t} - \frac{1}{c}u_x u_y \frac{\partial f}{\partial u_y} = 0$$

$$ct\frac{\partial f}{\partial x} + \frac{x}{c}\frac{\partial f}{\partial t} - \frac{1}{c}u_x u_z \frac{\partial f}{\partial u_z} = 0$$

The solution of the first is:

$$\frac{ct - \frac{xu_x}{c}}{x - tu_x} = f_1(x^2 - c^2t^2, y, z)$$

This gives a velocity X-component for any assigned point of space, and any instant. The substitution of u_x in the second and third equations and the integration thereof results in values for u_y and u_z in terms of x, y, z, t.

III

Accelerations are transformed by the special theory of relativity as follows:

$$\frac{d^2x_1}{dt_1^2} = \frac{\frac{d^2x}{dt^2}}{\beta^3\left(1 - \frac{vu_x}{c^2}\right)^3}$$

$$\frac{d^2y_1}{dt_1^2} = \frac{\frac{d^2y}{dt^2}}{\beta^2\left(1 - \frac{vu_x}{c^2}\right)^2} + \frac{\frac{vu_y}{c^2}}{\beta^2\left(1 - \frac{vu_x}{c^2}\right)^3}\frac{d^2x}{dt^2}$$

$$\frac{d^2z_1}{dt^2} = \frac{\frac{d^2z}{dt^2}}{\beta^2\left(1 - \frac{vu_x}{c^2}\right)^2} + \frac{\frac{vu_z}{c^2}}{\beta^2\left(1 - \frac{vu_x}{c^2}\right)^3}\frac{d^2x}{dt^2}$$

These relations may be easily derived thus:

$$\frac{dx_1^2}{dt_1^2} = \frac{d}{dt_1}\frac{dx_1}{dt_1} = \frac{d\left(\frac{u_x - v}{1 - \frac{vu_x}{c^2}}\right)}{\beta\left(dt - \frac{v}{c^2}dx\right)}$$

$$\frac{d^2x_1}{dt_1^2} = \frac{\frac{du_x}{dt}}{\beta^3\left(1 - \frac{vu_x}{c^2}\right)^3} = \frac{\frac{d^2x}{dt^2}}{\beta^3\left(1 - \frac{vu_x}{c^2}\right)^3}$$

Similarly:

$$\frac{d^2y_1}{dt_1^2} = \frac{d}{dt_1}\frac{dy_1}{dt_1} = \frac{d\left(\frac{u_y}{\beta\left(1 - \frac{u_x v}{c^2}\right)}\right)}{dt_1}$$

$$\frac{d^2y_1}{dt_1^2} = \frac{\frac{d^2y}{dt^2}}{\beta^2\left(1 - \frac{vu_x}{c^2}\right)^2} + \frac{\frac{v}{c^2}u_y\frac{d^2x}{dt^2}}{\beta^2\left(1 - \frac{vu_x}{c^2}\right)^3}$$

Likewise for $\frac{d^2z_1}{dt_1^2}$.

These equations for the transformation of accelerations are contained in the differential equations:

$$\frac{dw_x'}{3\,u_x\,w_x'} = \frac{dw_y'}{2\,u_x\,w_y' + w_x'\,u_y} = \frac{dw_z}{2\,u_x\,w_z' + w_x'\,u_z} = ic\,d\theta$$

from which they result by integration with the initial conditions that when

$$\theta \text{ or } v = 0,$$

then

$$w_x' = w_x$$
$$w_y' = w_y$$
$$w_z' = w_z$$

Here $w_x' = \frac{d^2x_1}{dt_1^2}$ etc.

In a future paper, the writer hopes to develop the consequences of these abstract formulae to the concrete relations and phenomena occurring in mechanics, astronomy, and electricity.

I beg to acknowledge the inspiration of my sister Ella in this work.

METEOROLOGY.—*A lightning stroke.* N. ERNEST DORSEY.

The detailed examination of a tree (height 47 feet, girth near ground 49 inches) which had recently been struck by lightning brought to light a number of facts[1] which do not readily conform to the usual ideas regarding the nature of a lightning stroke. Some of the more striking are these: (1) The tree was surrounded by the following objects, each about half the height of the tree distant from it: To the northwest was a tower which was $\frac{1}{8}$ higher than the tree; a tree of essentially its own height was to the southwest, another to the south and a third to the southeast; a tree about half as high was to the west and another to the north of east. Though surrounded in this manner, it was struck at an altitude of less than $\frac{1}{4}$ its height. At about twice its height distant, and on the other side of the building with the tower, was a tree of the same kind, about $\frac{1}{8}$ taller than the one which was struck. This was in a far more exposed position, but it was not damaged in the least. The building was not damaged, neither was another tree of the same kind, of nearly the same height, and about twice its height distant, although it was far more exposed than the one which was struck. (2) Other than by mechanical tearing, the bark and sapwood suffered only minor and very local damage, although one side of the tree was blown to pieces, and the unsplintered portion of the trunk was split. (3) The splintering extended to only a little more than half the height of the tree; the split reached the same height, but did not extend to the ground. (4) Along the apex of the blaze, which was about 4 inches from the bark and not at the center of the tree, there was a column of fibers which were quite completely shredded. This column extended from the roots to a point above the top of the split; it closely followed the grain of the tree. At all places, except one, it was separated from the bark by unshredded wood. The one place where it communicated with the bark was on the upper side of a minor branch, 15 inches above the top of the split. There, very near the trunk, was a small hole where the wood had been blown outwards and

[1] For a detailed account of the observations, see Monthly Weather Review, November, 1925.

the bark blown off. From this hole, a small tuft of shredded wood was projecting; the hole had been blown so empty that, by means of a No. 26 copper wire, it could be probed to a depth of 4 inches. (5) Along one edge of the splintered section there were four small spots where the bark had been charred. At three of them the bark had been perforated. The wood, back of the highest and largest spot, was so completely splintered that little could be learned regarding the nature of the hole; it appeared to have been nearly horizontal. A short distance beneath the bark there was a column of shredded fibers, then a region of little or no shredding, and then the shredded fibers at the apex of the blaze. The next hole, about a foot lower, could be quite satisfactorily reconstructed from the material available. Shortly after entering the trunk, it was scarcely larger in section than the lead of an ordinary pencil. It extended 2 inches beyond the bark, was inclined to the vertical by about 50°, and lay very nearly in the plane bounding that side of the splintered section. The third hole, which was about a foot lower than the second, merely penetrated the bark; it seemed to be inclined to the vertical by about 28°, but, on account of its short length, it was not possible to determine the angle with certainty. (6) Only one large section was torn from the tree. This section bore several branches; not far from its center, it was broken and bent, and the fibers were crumpled and crushed in such a way as to show that the lower portion had been forced violently into the upper. This occurred before the section left the tree. Attached to the lower portion, was a branch which, within the trunk, had been broken squarely across the grain, and pulled from the trunk as a tendon might be pulled from a mortise. And this was done so nearly that the fibers were not bent and that a sliver (one inch wide, $\frac{1}{4}$ inch thick, and 4 inches long, which was split from the branch) was left attached to the trunk and undamaged. Two inches of this sliver projected free from the undamaged portion of the trunk and had been pulled out of the section bearing the limb. Such a break could have been produced only by a longitudinal tension which was quite closely parallel to the fibers in the plane of cleavage between the sliver and the branch. In passing up and around the branch, the fibers of the trunk bend outward at the sides of the branch and then inward to the point where they meet above the branch. Thus, above the branch and at a certain depth within the trunk, the fibers are almost perpendicular to the plane of cleavage between the sliver and the branch; and a little nearer to the surface the overhang is still greater, so that

they form almost an inverted cup. This branch lay just within the western boundary of the column of shredded fibers. A small part of the column passed to the west and the remainder to the east of the branch; the two portions reunited above the branch, where the fibers are inclined and cupped, as just described. The shredded fibers lay in the boundary between the torn out section and the standing trunk.

Even a casual observer would have noticed that the center of violence was not over 10 feet from the ground, and there seems no room for doubt that the main discharge which caused the damage passed through the charred spots, of which the largest and highest was only 8 ft. 3 in. from the ground. Situated as the tree was, it seems certain that, prior to the advent of the stroke, the local field at these points could not have been essentially greater than that at many neighboring points; and must have been far less than that at the top of the tree, and still less than that at the top of the tower, or at the top of the exposed trees mentioned.

Also, it is difficult to believe that the electrical strength of the air along the narrow paths leading to the holes differed from that elsewhere sufficiently to more than offset the reduced field at these lower levels. And surely the conductivity of the fibers which were shredded was not significantly greater than that of those surrounding them, and must have been appreciably less than that of the sap-wood, which was undamaged.

The widely accepted belief that the path of the flash coincides at each point either with the direction of the antecedent local field, or with the antecedent line of minimum electrical strength, or with a compromise between these two, appears to be entirely incompatible with these observations. In many ways, the observations suggest that we are here concerned, not with ordinary conduction, in which the carriers of the electricity drift slowly and follow the direction of the local field, but rather with a mighty rush of carriers—with something analogous to the well-known cathode stream.

And this is fully in accord with the observation made by Sir J. J. Thomson at the beginning of this century, that a spark does not occur until, at some point, the field is sufficiently intense to confer upon an electron, in the interval between its encounters with the molecules, a velocity sufficient to enable it to dislodge an electron from the molecule with which it collides. Then, if there were no mutual repulsion between the several free electrons, and if the positive residues were removed so rapidly as to keep the field constant, a swarm of electrons

would result. The swarm would be elongated in the direction of the field, and the number of electrons in the swarm would increase exponentially with the length of the path. After the first encounter there would be two electrons, after the tenth there would be over a thousand, after the 60th there would be over 10^{18} electrons; which represents a gross charge of over 1/8 coulomb. For electrons moving with only a moderate velocity, 60 encounters will occur in a distance of about 40 microns. Owing to the mutual repulsion of the electrons, the swarm will tend to spread in all directions, but more especially in the direction of its motion; it will draw out into a dart. The leading electrons will be subjected to the repulsion of the trailing ones, as well as to the field arising from other causes, and hence their acceleration will be augmented. They will gain energy at the expense of the trailing electrons. Instead of a very great number of electrons moving at a moderate velocity, there will be a much smaller number moving with a correspondingly greater velocity. At velocities exceeding a certain value, the amount of energy an electron expends per unit length of path decreases as the velocity increases; consequently, at these velocities a weaker field will suffice to maintain the velocity. Once started with sufficient velocity, such a dart can continue to travel with unabated energy although the field is weak and, with a progressive reduction in energy, it can travel even in an opposing field. At high velocities, approaching that of light, the mutual fore-and-aft repulsion of the electrons is greatly reduced, and the effect of the attendant magnetic field (attraction of parallel currents) in great measure compensates the lateral repulsion. At these velocities the dart may be relatively compact. A high speed dart possesses a very considerable amount of momentum, and can strike a correspondingly powerful blow.

At low velocities, the path of a dart will coincide at each point quite closely with the direction of the local field existing antecedently to its arrival; as the velocity is increased, it will travel more and more under its own momentum, ignoring the local field. A high speed dart does not seek out a tree to strike, but merely collides with it. It makes no difference whether the tree is exposed or not; whether it is struck at the top or at the roots is merely a question of how it happens to be situated with reference to the path of the dart. True, the direction of the path just before collision will undoubtedly be modified by the presence of the tree, but the extent of the modification will be slight if the velocity of the dart is great. Where it collides, small

holes will be burned. Without other damage, the electrons will penetrate the trunk until their velocity is so reduced that they can become attached to the molecules composing the contents and walls of the cells; then their velocity abruptly decreases, and their progress becomes much more difficult. As their velocity is reduced, so is the magnetic field produced by their motion, and they are left more and more completely subjected to the full force of their mutual electrostatic repulsion, which urges them in all directions. In the particular tree studied, it appeared that the molecules were so crowded that they could not pass transversely to the grain without actually punching out the fibers ahead of them (as at the hole in the branch 15 inches above the split), but along the grain in the direction of the flow of the sap they could pass with a certain amount of freedom and in so passing the fibers were shredded. The longer the column over which the charged molecules are spread, the more pronouncedly longitudinal will be the resultant stress. If they can not pass across the grain, the tree will be splintered. The center of violence will be at the level of the entrance of the charge, and from this level the extent of the damage will decrease in both directions. In their passage up the fibers, in the case here considered, they encountered the overhanging fibers above the branch which was broken squarely across the grain, and which subjected them to a stress normal to their direction; this tore out the branch and drove upward the section of trunk containing it. Or, if it is preferred, we may say that a charge accumulated on these fibers, and was subjected to the repulsion of the charges which lay below them. Only a relatively small charge is needed to account for this damage. If there were only 1/600 coulomb on these fibers, and only twice as much at a point 30 cm. below it, the mutual repulsion would amount to more than the weight of 50 tons. This is more than ten times the longitudinal force required to tear apart a seasoned white oak rod having the same sectional area as the square break. Estimates of the amount of charge which could be involved in a lightning stroke run as high as tens and hundreds of coulombs, but what proportion of this is carried by the dart itself is not known.

If, while driving along the grain, the loaded electrons come sufficiently near the surface, the strength of the wood will be insufficient to stand the strain and the wood will be blown out and, through the opening so made, some of the shredded fibers will be ejected. Such was the case at the blow-out mentioned and also in the roots. Only

two of the latter showed damage, and in each case the center of damage was a single slender column of fibers. Where this came too near the surface a split occurred and the borders of the split were more or less shredded.

It seems that the observations which we have been considering can, on the basis of the present electron theory, be logically correlated with one another and with other well known facts by assuming that the stroke is initiated by a high speed dart of electrons. This delivers its entire charge practically at once, and is followed, along the ionized trail left by the dart, by a current of the usual type. This current will continue until there is such an equalization of potential that no more can flow, or until the negative carriers have become exhausted. If the conditions are such that at any point of the path, especially near the cloud, the field is sufficient to impart to the positive residues a velocity which enables them to dislodge electrons by collision, there will be a continuing supply of electrons until that condition ceases to exist.

Scattered throughout the atmosphere, below the cloud as well as in and above it, are regions in which the atmosphere is electrically charged; some are charged positively, others negatively. All are drifting under the action of the electric field, and are being carried hither and thither by the wind. Between two such regions, oppositely charged and suitably placed, the electrical field will be much greater than if these regions were uncharged. In such a place the dart may originate and acquire the velocity requisite for its continuance in the weaker, undisturbed field. The intensity of the field required to produce a dart depends in some measure upon the velocity with which the electron enters the field.

The dart which we have been considering traveled towards the ground. Obviously, under other conditions, a dart might originate at the ground and travel in the reverse direction. It would originate where the field is intense, as at the top of an elevated object. The dart itself would do no damage; the damage, if any, would arise from the current of positive residues. Like other charged gas molecules, these move relatively slowly and possess but little momentum, but on account of their great number they may convey a great current. They will not penetrate deeply into the trunk of a tree, but will pass mainly along the well conducting sap-wood, that will bear the brunt of the damage. Lightning strokes possessing these characteristics are well known.

In neither case is the stroke the result of the cloud discharging to earth, though the cloud does become discharged as a result of the

stroke. That, however, is purely an incidental and a subsequent effect. The negative charge of the dart is assembled along the path; the remainder of the charge involved in the stroke comes from the ionization produced by the dart. The charges in the cloud are, probably in large part, neutralized *in situ*, either by the spreading of the delivered charge by its own mutual repulsion, or by the dissemination of the ions by the wind. It is distinctly an after effect of the spark.

Such seems to be the essential nature of a lightning stroke. There is first a rush of electrons, which blazes the path, then, along this conducting path, flows a more leisurely conduction current of the usual type. Under certain conditions, perhaps usually, this conduction current will convey a far larger quantity of electricity than is carried by the dart of electrons. The direction in which the dart flies is in a very real sense the direction of the stroke—the direction in which it is delivered. The effects produced where the stroke starts differ quite characteristically from those produced where it ends.

PHOTOGRAPHY.—*Photography for the field geologist.* ELIOT BLACKWELDER. Stanford University.

GENERAL

Nearly every field geologist carries a camera; but it is a common experience at the end of the season to find that pictures taken of some of the most important subjects were failures and that a much larger number were neither as distinct nor as bright as they should have been. This is due to the fact that the taking of good photographs under all sorts of conditions is an art understood by but few users of the camera. Success in it requires a comprehension of certain facts and principles and close attention to the necessary details. The accuracy of photographs as records of field conditions makes them a valuable supplement to the usual notes, maps and sketches; and therefore it is advisable for every geologist to inform himself to such an extent that he may be able to take good photographs under nearly all possible conditions. As a result of some twenty-five years of more or less painful efforts to reach such proficiency, the writer ventures to offer the younger geologist a few suggestions that may improve his results. In general the difficulties are not the same as those which confront the professional studio photographer, and so these remarks apply more particularly to field work.[1]

[1] A paper of interest in this connection is *Stereoscopic Photography in Geological Field Work*, by F. E. Wright. This JOURNAL 14: 63–72. 1924.

EQUIPMENT

Good results should not be expected without good equipment. The small pocket camera is not capable of giving photographs of much use to the geologist, except for nearby objects under favorable light conditions. Therefore he will do well to provide himself with a more elaborate camera, equipped with a ground glass for focussing, and as large as he can reasonably carry. The 5 × 7 inch size is one of the most satisfactory, but in some kinds of work a smaller camera may be all that circumstances permit.

One of the most important things is to get the best convertible lens and shutter that can be obtained. After trying various lenses, the writer finds that the Goertz Dagor type gives the sharpest detail; but some prefer other convertible lenses, such as the Zeiss Protar or Tessar, the Bausch and Lomb, or the Cooke lenses. One of the best shutters is the Compound; but there are others in the same class. It is advisable to have a lens consisting of two elements, one of which can be removed to permit using a long focus for telephoto views. For this purpose it is necessary that the camera have a rather long bellows.

To record the picture one now has considerable range of choice. Glass plates are perhaps the best means, but their fragility and weight are serious disadvantages in the field. Fortunately, cut films, which are free from such defects, give almost equally good results. Roll-films and film-packs are distinctly inferior on account of their slight tendency to curvature, so that they seldom give as sharp images as plates. Nevertheless, they are tempting because of their greater convenience, and they may well be used for photographs of minor import or those in which minute detail is not required.

Various kinds of cut films may now be obtained for different purposes. For moving objects, or for taking views from trains or from windy stations, rapid films, such as Eastman "Portrait Super-Speed" film, may be required; but the results are usually not as good as those obtained with slower films. For general work within one or two miles of the camera, and where it is not important to bring out the more unusual colors, Eastman "Commercial Ortho" and other equivalent films are satisfactory. For distant mountain pictures with more or less blue haze, or for any pictures in which colors need to be especially differentiated, the writer finds nothing equal to "Panchromatic" films. In fact, he has found nothing else that will give even tolerably satisfactory results in photographing desert mountain scenery,

where the blue haze is nearly always in evidence. The only disadvantages to using Panchromatic films are their slightly greater cost, and the fact that they must be loaded and developed in darkness.

Ray-filters, or color screens, are indispensable for many geologic photographs. It is best to carry several kinds for different purposes. The function of the ray-filter is to equalize the rays of various photic intensities and thus to give truer color-values. A suitable filter is particularly important for the purpose of counteracting the effects of the blue and violet rays which predominate in the light coming from distant mountains. In photographing ordinary landscapes with Commercial Ortho films, the author has found the Wratten *K*-1 filter (made by the Eastman Kodak Company) satisfactory. When using Panchromatic films on distant mountains or desert scenes, best results have been obtained with the *G* filter of the same series,—a rather deep orange-colored glass. Even better results are given by using a red filter, but this requires about five times as much exposure, and that is a serious disadvantage when the wind is blowing. Various smaller ray-filters for pocket cameras are on the market.

Sharp definition of the details in a photograph depends partly upon accurate focussing of the lens and partly upon the stability of the camera. If a scale is used for focussing, it is advisable to test the scale carefully before going into the field, and it is also necessary for the operator to be sure of the distance to be covered in each photograph. In general, it is probably best to focus on the ground glass every time, and for this purpose it is desirable to carry a black cloth to shut out the light.

Beginners seldom realize the importance of stability of the camera. It is true that very rapid exposures, such as $\frac{1}{250}$ of a second, may be taken from a moving train or when a violent wind is blowing; but ordinary snapshots, even with an exposure of $\frac{1}{50}$ of a second, generally show the effects of slight movement. With the slower films and ray-filters, it is necessary to use a solid support, such as a tripod. While the ordinary tubular metal tripod is better than none, and may be satisfactory in calm weather, it is not stable enough for ordinary conditions. It is much better to use a fairly heavy wooden tripod of the type that can be folded into a small space.

It is now possible to obtain for the tripod head a ball-and-socket joint attachment that facilitates the photographing of objects on the ground or in other awkward positions. However, for a heavy camera it may be necessary to have such an attachment specially reinforced

to overcome vibration. Still better, one can use the tilting tops that are now obtainable; they are screwed on the top of the usual tripod.

One of the most important problems confronting the photographer is that of the length of exposure to be given when taking the picture. Since this varies with the latitude, altitude, sky conditions, climate, nature of subject, time of year, hour of day, distance from subject, shadows, etc., it is really a very complex problem. To facilitate the necessary calculations, it is almost essential to use some kind of exposure meter. Of these there are now many types on the market. The writer has obtained best results with the Harrold exposure meter, and finds it compact, durable, and easy to operate. Only the most experienced photographer can afford to depend upon judgment or memory, when it comes to estimating the length of exposure required in a given case, except where all of the various conditions are what may be called normal.

TAKING THE PICTURE

It is well to remember that the camera is not capable of giving everything that the human eye can see. In order to show topographic details, the light must be favorable. Since it is the small shadows that bring these details into prominence, it is best to take the picture from such a position that the sun's rays are nearly at right angles to the line of sight. For the same reason, photographs taken within two hours of sunrise or sunset show the greatest detail in mountain slopes, because the shadows are longer then than at noon.

Timing the exposure is perhaps the most acute problem at the moment of taking the picture. Exposure meters are usually devised for the conditions which prevail in the populous part of the eastern United States. For other regions certain allowances must be made. For example, in the western plateaus and mountains, at elevations of about 5000 feet, it is found necessary to reduce the time to one-half that which is indicated by the exposure meter. Above 10,000 feet, it should be reduced to one-third. On the deserts of the southwestern states, similar reductions should be made at much lower altitudes,—2000 and 6000 feet respectively. Few people realize how important the factor of distance is, in this respect. At a distance of 2 to 3 miles, the time should be further reduced about 10 per cent; and for 25 or more miles, about 50 per cent, as compared with nearby objects. It is often impracticable to obtain a good image of both the near and the distant objects; but suitable films and ray-filters, with carefully calcu-

lated exposures, will give fair results that are impossible without them.

In order to photograph very light-colored objects, such as desert plains, quartzite outcrops, sand dunes, snowy peaks, and lakes, it is necessary further to reduce the time of exposure by 25 per cent to 75 per cent, according to the degree of reflection of light from the surface in question. One must acquire by experience an intuitive perception of the light-reflecting properties of the various subjects to be photographed.

There is another correction which is nearly always overlooked, but which is rather important when taking photographs at early or late hours in certain parts of the country. It should be remembered that the exposure-meter has been designed for correct time, i.e., solar time, but that our watches generally give "standard time." It therefore happens that if one is situated near the boundary between two standard time zones, his watch is in error as much as half an hour with reference to solar time.

In order to obtain contrast in the larger outlines of the picture, it is better to under-expose the film a little. On the other hand, to obtain detail in smaller objects, especially within a few feet of the camera, it is better to over-expose somewhat. For example, a dissected mountain slope some miles away would show best in the former case, and a rock specimen photographed in the laboratory would need the latter.

FINISHING THE FILMS

Developing and printing are important operations. They should be performed only by experts who are instructed in advance regarding the general nature of the photographs that have been taken and the kind of negatives especially desired. It is unwise to entrust such matters to the ordinary drug-store agency, or even to the average town photographer. It is best to seek out a qualified, experienced photographer, explain one's problem to him, and then send him all the films, even though it sometimes involves more or less delay. It is especially important never to let a careless or inexperienced person either load or develop the highly sensitive Panchromatic films.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY

927TH MEETING

The 927th meeting was held in the auditorium of the Cosmos Club on Saturday evening, November 28, 1925. The meeting was called to order by President FLEMING at 8:15 with 46 persons in attendance.

Program: G. BREIT and M. A. TUVE. *Radio evidence of the existence of the Kennelly-Heaviside Layer.* (Presented by Mr. BREIT and illustrated with lantern slides.) A method of testing for the existence of the Kennelly-Heaviside Layer has been described by the authors (see *Journal Terrestrial Magnetism and Atmospheric Electricity*, March, 1925). This method has given a definite indication of the existence of the layer. The transmission took place from Bellevue, Anacostia, as well as other stations. The layer is found to have different reflecting powers for different wave-lengths. Its properties change rapidly with time. Frequently it is capable of sending down more than one wave. This appears to be especially true in the afternoon and at night. The effective height of the layer is not quite constant but varies. It is generally in the neighborhood of 100 miles. The wave returned from the layer is differently polarized from the wave traveling along the ground.

Discussion. The paper was discussed by Messrs. WHITE, HUND, LAPORTE, BAUER, GISH, CURTIS, MOHLER and WENNER.

V. E. WHITMAN. *Studies in the electrification of dust clouds.* (Illustrated with lantern slides.) Dust clouds were formed by blowing various pure chemical substances through tubes and the net electric charge imparted determined as a function of the composition of the dust, tube material, area of contact between the dust and the tube in being blown out of the tube, velocity with which the dust moves through the tube, and the length of the path of the dust through the tube. An apparatus was described with which photographic records of the paths of particles are obtained. Such photographs show the presence of positive, negative, and neutral particles in all dust clouds, even of very pure substances. The ratio of positive to negative electrification in a cloud is found to change as the larger particles in the cloud settle out, but evidence is obtained which contradicts the hypothesis that the large particles carry an opposite charge from the small particles in a given cloud. The paper closed with a few remarks bearing on the relation of the present experimental data to the concept of a tribo-electric series. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. DRYDEN, TUCKERMAN and SILSBEE.

928TH MEETING

The 928th meeting, constituting the 55th annual meeting, was held in the Cosmos Club auditorium Saturday, December 12, 1925. It was called to order by Vice-President AULT at 8:16, with 37 persons present.

The report of the Treasurer showed total receipts, $3328.44; disbursements, $2974.70, leaving a balance of $353.74. The report of the secretaries showed that 18 meetings were held during the year, several in conjunction with other societies.

The following officers were elected for the ensuing year: *President,* WILLIAM

BOWIE; *Vice-Presidents*, J. P. AULT and PAUL R. HEYL; *Treasurer*, W. D. LAMBERT; *Corresponding Secretary*, H. L. DRYDEN; *Members-at-Large, General Committee*, G. BREIT and E. W. WOOLARD.

At the conclusion of the business meeting Dr. WILLIAM H. DALL addressed the Society on *Some recollections of the founding of the Philosophical Society*. The address was highly appreciated, the presiding officer voiced the sentiments of all present in thanking Dr. DALL for his address. Following Dr. DALL's address Prof. JAMES H. GORE and Dr. WILLIAM H. HOLMES also spoke on the early days of the Philosophical Society.

H. A. MARMER, *Recording Secretary*.

THE BIOLOGICAL SOCIETY

681ST MEETING

The 681st meeting of the Biological Society was held in the assembly hall of the Cosmos Club, October 24, 1925, at 8 p.m., with President ROHWER in the chair and 51 persons present. W. F. RUBEY, Geological Survey, was elected to membership.

VERNON BAILEY described the effects of fire in destroying muskrats in marshes in Louisiana. Many muskrat houses are burned and dozens of the animals are sometimes found dead. In places where extensive fires occur, it is estimated that thousands of muskrats may be killed.

J. N. ROSE reported that plans are being made for a 5,000 acre arboretum with a prospective endowment of $20,000,000 near Los Angeles, California.

A. A. DOOLITTLE described examining a cat found in poor condition. It proved to be heavily infested with tape worms of a species usually met with in man.

S. A. ROHWER announced the recent death of a member, Dr. W. D. HUNTER of the Bureau of Entomology, in El Paso, Texas. Dr. HUNTER, who had been in charge of important work in Texas for some years, was formerly active in entomological and other biological work in Washington.

P. B. JOHNSON referred to observations on viscachas recently living in the National Zoological Park. After a heavy rain a young one of a more bluish color than older animals was seen nestling close against the body of an adult male, presumably for warmth.

VERNON BAILEY, Biological Survey: *Two years' progress in beaver farming*.—Two beaver colonies established in 1923 in northern Michigan, where the animals are thriving and increasing in a satisfactory manner, were described. From one fully enclosed area one of the beavers escaped by digging under the fence when their dam raised the water above the bottom wires, but in a short time returned and was admitted to the inclosure with its companions. In the other colony, where only a drift fence had been built across the creek below them, a few of the beavers had crossed to the head of a neighboring creek and a second colony was established. This can be controlled by another short section of fence across the creek and meadow below. Both colonies are in excellent location for beaver farms.

The importance of feeding beaver when the food supply near the shores is exhausted was emphasized and lantern slides of some of those caught in Mr. Bailey's improved beaver trap were shown. (*Author's abstract.*)

AGNES CHASE, Bureau of Plant Industry: *Hunting grasses in Brazil*.—The speaker spent 7 months in Brazil, visiting the states of Pernambuco, Alagoas, Bahia, Rio de Janeiro, Minas Geraes, and São Paulo. The sertão

of both Pernambuco and Bahia was badly overgrazed. A trip was made to Paulo Alfonso Falls in Rio São Francisco. The falls, which are 81 meters high in all, form a stupendous cascade, not a straight fall. The region is a rocky desert with very little vegetation. In January Mrs. Chase botanized in the region about Rio de Janeiro and with a party from the Jardim Botanico visited Itatiaia, the peak of which, Agulhas Negras, was until recently believed to be the highest point in Brazil. Its altitude is now in dispute. On the ascent through tropical jungle a group of monkeys was seen. Above timber line grasses were abundant. About three months were spent in Minas Geraes, the highland campos of this state being especially rich in grasses. Serra de Cipó, 150 kilometers northwest of Bello Horizonte, yielded the best results of the entire trip. Three weeks were spent in the vicinity of Viçosa in the eastern part of Minas Geraes, where Dr. P. H. Rolfs is building up a school of agriculture for the state. With Dr. Rolfs and his daughter a trip was made to Serra da Gramma, and later with Miss Rolfs to Serra de Caparaó. The highest peak of this range, Pico de Bandeira, 2884 meters, disputes with Agulhas Negras the place for highest point in Brazil. The party ascended Pontão Crystal, 2798 meters, instead of Pico de Bandeira, 2884 meters in altitude, but the botanical results were probably as good as if the higher peak had been attained. A last trip into highland campos was made to Campos de Jordão, São Paulo. (*Author's abstract.*)

682D MEETING

The 682d meeting was held in the assembly hall of the Cosmos Club, November 7, 1925, at 8:05 P.M., with President ROHWER in the chair and 59 persons present. FRANK THONE, Science Service, Washington, D. C., J. K. STRECKER, Baylor University, Waco, Tex., and GEORGE M. LIND, Fort Collins, Colo., were elected to membership.

H. C. OBERHOLSER referred to the establishment of the Upper Mississippi River Wild Life and Fish Refuge by Act of Congress providing for the purchase of over 300,000 acres of overflowed lands along the Mississippi River from Rock Island, Ill., to Wabasha, Minn. A sum of $1,500,000 has been set aside, a part of which is now available for the acquisition of lands by the U. S. Department of Agriculture through the Biological Survey, which in cooperation with the Bureau of Fisheries will administer the area. Attention was directed to the high value of this great refuge, the object of which is to conserve recreational and economic resources in the interest of all the people.

VERNON BAILEY mentioned seeing a woodchuck near Washington and requested that members report any similar observations, with dates, with a view to securing more definite information relative to the length of the hibernation period of this animal in the District of Columbia.

F. C. LINCOLN reported seeing a woodchuck about a month ago near White's Ferry, Va. Its actions were unusual as it came running down the road and passed close between him and a companion before finally turning off into the brush.

L. O. HOWARD, Bureau of Entomology: *Something about the salt marsh mosquito problem.*—The speaker described the biology of the most prominent salt-water mosquitoes, namely *Culex sollicitans* and *Culex taeniorhynchus*, showing that in spite of his own efforts to learn the life histories of these species, they were not understood until a very thorough investigation had been made by the late Dr. John B. Smith, State Entomologist of New Jersey (and former Secretary of the Biological Society of Washington), and his

associates in 1902. He then spoke of the extraordinary work that has been done by the State of New Jersey along its whole ocean front in draining and diking the marshes so as to prevent the breeding of these mosquitoes which were for years the dominant mosquitoes of New Jersey and which had given that State its mosquito reputation. Both forms fly for great distances, and in the summer may be found 40 miles from the coast.

The speaker mentioned other salt-marsh work which had been done on Staten Island, in Connecticut and, to a slight extent, in Florida; and then proceeded to tell about the great scourge of mosquitoes along the Gulf coast of Louisiana, Mississippi, and Alabama during the past season, which had aroused great excitement among the owners of property in these regions and had caused them to organize a survey of mosquito conditions which eventually may bring about a large-scale effort to drain the marsh breeding places. The speaker pointed out that this would be an enormous undertaking. He showed that, of the approximately 12,000 square miles of salt marsh on the whole of the Atlantic, Gulf and Pacific coasts of the United States, more than 6,000 square miles are included in the State of Louisiana. Complete and successful work will probably cost an enormous sum of money, but the value of the reclaimed land, to say nothing of the abatement of the mosquito scourge, will undoubtedly make such work well worth while. (*Author's abstract.*)

E. A. GOLDMAN, Biological Survey: *Over-browsing by Kaibab deer.*—The deer inhabit the Kaibab Plateau on the north side of the Grand Canyon of the Colorado River, embracing an area set aside as the Grand Canyon National Game Preserve in 1906, and a part of the territory now included in Grand Canyon National Park. There is little migration from the area and, under protection from hunters and partial protection from predatory animals, the deer have increased to numbers estimated by some at more than 30,000. The forage producing capacity of the area is being progressively reduced by over-browsing until it has reached a point where many deer are threatened with starvation.

In addition to the wide-spread destruction of shrubs favored by deer, forest trees, especially reproduction of aspen, yellow pine, pinyon, white fir, spruce and juniper are being seriously injured or killed. The critical situation that has arisen emphasizes the importance of regulating the numbers of game on limited areas in accordance with the forage supply, as a general conservation measure. The Grand Canyon National Game Preserve, with boundaries nearly identical with those of the Kaibab National Forest is under the administrative control of the Forest Service which is seeking a solution of the many-sided problem. (*Author's abstract.*)

683D MEETING

The 683d meeting of the Society was held in the assembly hall of the Cosmos Club November 21, 1925 at 8:05 P.M., with President ROHWER in the chair and 120 persons present. Dr. F. H. CHITTENDEN and Miss MABEL COLCORD were elected to membership.

T. S. PALMER, Biological Survey: *Report on the recent meeting of the American Ornithologists' Union, New York.*—The speaker gave an account of the annual meeting of the American Ornithologists' Union held in New York City in November, referring especially to the exhibition of the bird paintings and to the widespread membership of the Union. Mention was made of the next meeting of the Union, to be held in Ottawa, which will be the first meeting held outside the United States.

W. C. HENDERSON, Biological Survey: *When the elk come down.*—Of the two large herds of elk now in existence in the United States, the principal herd is that in the Jackson Hole region in Wyoming. Under the protection afforded it, the herd is increasing rapidly in numbers and to such an extent that the greatest problem connected with its preservation is that of providing sufficient food in winter. The only solution that seems practicable is that of keeping down the numbers by more extensive hunting in the open season. The speaker showed slides illustrating the herd and in conclusion gave a moving picture film, prepared by the Biological Survey, showing the way in which elk are killed by poachers for the sake of the teeth.

H. C. OBERHOLSER, Biological Survey: *Birds on the Farallon Islands, California.*—The speaker described the Islands and showed moving pictures illustrating the murres, guillemots, cormorants, gulls, and petrels, which make up the bird life. The most abundant birds are the murres, whose numbers are estimated at about 20,000.

H. C. OBERHOLSER: *The bird reservations of Louisiana.*—The speaker showed films illustrating the bird refuges on small sandy islands off the coast of Louisiana, which are populated principally by laughing gulls and royal terns, together with a much smaller number of shore birds, such as willets.

684TH MEETING

The 684th regular meeting of the Biological Society was held in the assembly hall of the Cosmos Club December 5, 1925, at 8:05 P.M., with President ROHWER in the chair and 48 persons present. Dr. D. N. SHOEMAKER was elected to membership.

L. D. MINER reported the observation of a black-billed cuckoo feeding on caterpillars along the canal in the vicinity of Washington on 28 October.

A. S. HITCHCOCK spoke of the close relationship between the floras of the northeastern United States and northeastern Asia and added another to the already long list of identities in the two floras, *Brachyelytrum erectum.* This is a common grass in the northeastern United States, and was recently found by him in a collection sent from China.

W. B. GREELEY, Forest Service: *The proposed changes in the boundaries of Yellowstone National Park in relation to wild life* (illustrated).—The speaker discussed the existent National Forests and National Parks with special reference to the proposed enlargement of the boundaries of Yellowstone National Park to include the rest of the Yellowstone River basin, most of the Grand Tetons, and the winter range of the Jackson Hole elk herd. With the other members of the coordinating committee appointed at the recent Conference on Outdoor Recreation called by President Coolidge, he made a trip through the area during the past summer. The paradise of wild life found in the vicinity of Bridger Lake was described, with illustrations of the scenery and of the bear, elk, moose, mule deer, bighorn, and other large mammals. The problem of providing winter food for the Jackson Hole elk herd still awaits solution. The speaker proposed the restriction of the herd by hunting to about 15,000 as the only way to prevent the starvation of large numbers of elk in bad winters. The additions proposed to Yellowstone Park follow natural drainage lines instead of the present artificial boundaries, and small additions on the northwest and northeast sides and a larger one on the southeast, with some restriction of boundary on other sides. The coordinating committee has recommended that the Grand Tetons area be preserved in a completely wild state as a National Park.

The paper was discussed by S. T. MATHER, who accompanied Col. GREELEY as a member of the coordinating committee. He reported that the Hopi Ranch north of the Yellowstone had recently been purchased from a privately raised fund and will be used as a shelter for antelope in winter.

T. H. KEARNEY, Bureau of Plant Industry: *Pollination in cotton* (illustrated).—Cotton plants are adapted for both close and cross-fertilization. Close fertilization is desired by plant breeders to preserve the purity of selected strains, and insect pollination must be prevented. Experiments show that insect pollination is much more effective at Sacaton than near Phoenix, Arizona, owing to the greater comparative abundance of insects, especially honey bees. Few natural hybrids occur, even if both Egyptian and upland cotton are grown close together, owing to the fact that the bulk of the pollen grains on the stigmas are found to be self pollen. Selective fertilization—the greater effectiveness of like pollen than of an equal amount of unlike—also tends to prevent the formation of hybrids. Hybrids in the F_1 generation are uniform and intermediate in most characters, but in F_2 the characters break up badly. Strict inbreeding for seven generations has produced no bad effect.

685TH MEETING

The 685th regular and 46th annual meeting was held in the lecture hall of the Cosmos Club December 19, 1925, at 8 P.M., with President ROHWER in the chair and 24 persons present. The minutes of the previous Annual Meeting were read and approved. New members elected: C. DENLEY, G. B. GRANT, O. J. MURIE.

The annual reports of the Corresponding Secretary, the Recording Secretary, the Treasurer, and the Publication Committee were read and ordered placed on file. T. S. PALMER, for the Board of Investing Trustees, presented an informal report showing that the George Washington Memorial Fund amounts to $600, that there is about $1500 in the Publication Fund, and the sum of $430 is due the Publication Fund from the General Fund. F. C. LINCOLN gave a sketch of the history of the George Washington Memorial Fund.

The election of officers then took place, resulting as follows:

President, H. C. OBERHOLSER; *Vice-Presidents*, E. A. GOLDMAN, A. WETMORE, C. E. CHAMBLISS, H. H. T. JACKSON; *Recording Secretary*, S. F. BLAKE; *Corresponding Secretary*, T. E. SNYDER; *Treasurer*, F. C. LINCOLN; *Members of Council*, H. C. FULLER, W. R. MAXON, C. W. STILES, A. A. DOOLITTLE, B. H. SWALES. President-elect H. C. OBERHOLSER was nominated as a Vice-President of the Washington Academy of Sciences to represent the Biological Society. On motion of Dr. STILES a rising vote of thanks was given S. A. ROHWER for his efficient service in the presidential chair.

ENTOMOLOGICAL SOCIETY

376TH MEETING

The 376th meeting was held in Room 43 of the New National Museum, Thursday, June 4, 1925, with President R. A. CUSHMAN in the chair and 17 persons present. THOMAS R. CHAMBERLAIN of the Bureau of Entomology, Salt Lake City, Utah, was elected to membership.

Program: C. H. RICHARDSON: *Some aspects of insect physiology.*—Certain aspects of physiology as applied to insects were presented briefly. General physiology has suffered a one-sided development largely because the higher

vertebrates, particularly man, have been the subjects of most of the investigations. Digestion in insects was compared with that in the vertebrates, and with a few exceptions was shown to present no unusual features. Absorption from the alimentary tract and from the malpighian tubules was discussed and the need for more studies on permeability was emphasized. A discussion of the nutritive requirements of insects concluded the paper. It was discussed by Dr. McIndoo.

C. Heinrich: *Comments on the distribution of the European pine-shoot moth.* A trip was recently made through New Jersey, New York, Connecticut, Massachusetts, and Rhode Island to determine the present status of the European pine-shoot moth (*Rhyacionia buoliana* Schiffermüller). The situation today is about what it was in 1914 except that on Long Island a greater area is infested, *R. buoliana* having appeared in many new localities and on a number of private estates that were uninfested in 1914. The species was also found in Tarrytown, N. Y., and at Newport and on the Duke estate at Somerville, N. J., but in several other places where it had been found in 1914 it was no longer present. In Tarrytown and Somerville and in the nurseries at Newport it was considerably less abundant than formerly, owing to efforts by nurserymen and gardeners to eradicate the insect. In a few localities about Boston and in Connecticut where it had been located in 1914 it was not found on the recent trip. The situation was summarized as follows: *R. buoliana* has been able to survive local conditions and to thrive in this country for something like thirteen or fourteen years. It is established and well distributed on Long Island, which will remain, as long as the insect is there, a source of infestation for other places. It is also well established, though not so widespread, in Newport and vicinity, and it has been distributed from nurseries to various private estates in New York, Connecticut, Rhode Island, New Jersey and probably in other localities further west. Attempts have been made by nurserymen and gardeners to eradicate the pest in their localities by cutting buds, but this work, though conscientious, has not been under the supervision of an entomologist and has not been thorough. Consequently the moth has persisted in most of the localities where it has been introduced. In places where the clean-up has been thorough (at points in Massachusetts and at Great Neck, L. I.) the insect has completely disappeared. It has apparently not escaped into any of our forests or into large plantings or standing growths of native pines. The advisability of eradicating this moth from the United States before it becomes a forest problem was urged. The paper was discussed by Messrs. Aldrich, Baker, Böving, Graf, and McIndoo.

Dr. Böving exhibited a recent book from Denmark, which contained numerous fine pictures of the pine-moth work in Denmark.

R. A. Cushman: *Some parasites of the pine-tip moth.*—Parasites reared from the pine-tip moth, *Rhyacionia frustrana* Comstock, were considered in connection with a projected attempt to colonize them in the Nebraska National Forest, where the host has caused great havoc in the young pine. The habits of the various species in relation to the host and their relative abundance and effectiveness were discussed. The paper was discussed by Messrs. Baker, Craighead, Heinrich, Richardson and Rohwer.

377TH MEETING

The 377th meeting was held in Room 43 of the New National Museum, Thursday October 1, 1925, with President R. A. Cushman in the chair and 38 members and 14 visitors present.

Mr. CUSHMAN announced that since the last meeting the Society had lost by death, Dr. B. H. RANSOM, who passed away September 17, 1925. A committee composed of Dr. M. C. HALL, Dr. H. E. EWING, and Mr. S. A. ROHWER drew up the following resolution which was read and adopted by the Society:

Resolution: Dr. BRAYTON HOWARD RANSOM, Chief of the Zoological Division of the Federal Bureau of Animal Industry and for many years a member of the Etomological Society of Washington, died September 17, 1925, at the age of forty-six years. In his investigations in the broad field of animal parasitology, Dr. RANSOM made frequent contributions to the subject of medical and veterinary entomology. His publications which have a direct bearing on entomology include a wide range of subjects, such as habits and biology of the Texas fever tick; arsenical dips for ticks; eradication methods for ticks; a nematode parasite of the house fly and certain dung beetles; miscellaneous cattle parasites; and sheep scabies. Perhaps his most comprehensive paper on insects is that published in Pierce's "Sanitary Entomology." This paper deals with the relation of insects to the parasitic worms of vertebrates. The studies of arsenical dipping for the control of ticks conducted by Dr. RANSOM and his collaborator, H. W. GRAYBILL, are basic investigations of great economic importance. Dr. RANSOM was a man of great modesty and personal charm, a delightful friend and companion and a man of sound judgment and conservative ideas. His advice and counsel were highly prized by his associates and collaborators. His death at such an early age is a loss to science and his friends. The Entomological Society of Washington regrets the loss of this active worker and wishes to record its sincere appreciation of the man and the scientist.

W. H. LARIMER of the Bureau of Entomology, Washington, D. C., was elected to membership.

Program: Dr. L. O. HOWARD: *The Third International Congress of Entomology at Zurich.*—The speaker described briefly the principal features of the congress held at Zurich, July 19 to July 26, 1925, and showed on the screen portraits of forty or more to the principal delegates from different countries, reproduced from photographs taken by himself at Zurich.

Dr. J. B. PARKER: *Some notes on the nesting habits of Bembix comata* Parker. —This paper has been published in full in PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON (**27**: 189–195. 1925).

Dr. WILLIAM BARNES of Decatur, Illinois, spoke briefly about his trip abroad.

Dr. E. A. BACK spoke of a soap spray for *Aleyrodidae*, stating that enough of the oil remained on the leaves to kill the eggs. He also spoke of a new process for spraying raisins that is used at Fresno, California. If successful, it will be of greater value than the old methods.

Dr. T. E. SNYDER gave the following note on *Mastotermes darwiniensis* Froggatt: Dr. GERALD HILL of Australia, one of the active British students of termites has recently discovered that *Mastotermes darwiniensis* Froggatt, the primitive Australian termite, lays its eggs in a mass similar to that of the *Blattids;* this mass is approximately 5 mm. in length and consists of two parallel rows of eggs cemented together; 14 to 24 eggs to a mass.

In the Blattids, Mantids and *Mastotermes*, Crampton had found that the seventh sternite in the female was prolonged and that this covered the ovipositor. The roach-like wings of *Mastotermes*, the large anal area, and this egg mass, similar to an oothecum, further establishes the relationship of termites to the ancient roaches. Three fossil species of *Mastotermes* have been

found in England, one in the Upper Eocene and two in the Middle Oligocene. A primitive South African genus of termites has recently been discovered as a fossil in the Rott of Germany.

378TH MEETING

The 378th meeting was held in room 43 of the New National Museum, Thursday, November 5, 1925, with President R. A. CUSHMAN in the chair and 30 members and 13 visitors present.

MR. CUSHMAN announced the death of Dr. W. D. HUNTER, which occurred October 13, 1925, at El Paso, Texas.

A committee composed of Messrs. C. L. MARLATT, F. C. BISHOP, A. BUSCK, and Dr. L. O. HOWARD, chairman, drew up the following resolution:

Resolution: The announcement of the death of Dr. WALTER DAVID HUNTER has caused the members of the Entomological Society of Washington to sorrow very deeply. Although seldom present at our meetings of late years, Doctor HUNTER was the dear friend of many of us, and all of us respected him and admired him for his notable achievements in applied entomology. We realize that by his work and his sound judgment and by his high character as a man he had gained the confidence of the people, especially of the South, to an unparalleled degree. We realize further that he has had a most important influence in the awakening of a realization of the very great value of entomological work. No memorial could express adequately the value of his life work, and we can only grieve with others that blind fate should have stopped it in mid-career. The Society authorizes the preparation of a biographical account of Dr. HUNTER, and its publication together with his bibliography in the PROCEEDINGS OF THE SOCIETY.

This resolution was adopted.

Program: Dr. A. G. BÖVING. *Entomological collections in the museums of Denmark and Sweden.*—The speaker explained the educational training required for the attainment of the scientific positions in the Scandinavian museums, and mentioned the salaries, working hours and holidays that go with these positions. Rather detailed information was given concerning the arrangement and the contents of the entomological main collection in the Copenhagen Museum and on the origin and history of its most valuable special parts. Biographical remarks were added on the two famous Danish entomologists, FABRICIUS and SCHIODTE, the latter a most enthusiastic and successful collector and observer in the field. The personalities and scientific contributions of some of the now living Danish entomologists were sketched.

Dr. STEPAN SOUDEK, Assistant, Zoological Institute of the College of Agriculture and Forestry at Brno, Czechoslovakia, spoke briefly to the SOCIETY.

Dr. J. BEQUAERT of the Harvard School of Tropical Medicine spoke briefly on the *Tabanidae* or horse flies as disease carriers.

A. T. GAHAN reported two interesting records of little known parasitic *Hymenoptera*. The material was received from GUY A. K. MARSHALL, Director of the Imperial Bureau of Entomology, London, England. There were four males of *Paracarotomus cephalotes* Ashmead reared from a pupa of *Paragus* sp. at Ibadan, South Nigeria, by O. B. Lean, and *Telenomus nawaii* Ashmead reared from eggs of *Prodenia litura* at Levuka, Fiji.

Dr. J. M. ALDRICH spoke of the high prices charged for the German scientific publications, especially those in "Archiv. für Naturgeschichte."

Mr. SHANNON made a few remarks regarding the use of the name "insect" in which he referred to his proposal made at the 373d meeting to apply this

name to all Arthropods exclusive of the Crustacea. He read from a recently published book on medical entomology by Dr. CARROLL FOX, "Insects and Diseases of Man," the definition given for medical entomology: "Entomology is that part of zoology which treats of insects. . . . . It is generally agreed that the term medical entomology may include acarines or other arthropods which have been implicated in the occurrence or spread of disease." This shows that the medical entomologist at least finds it convenient to use the name "insect" as was proposed by the speaker.

Mr. ROHWER told of receiving a specimen of *Tiphia punctata* Robertson which had been collected by HAROLD E. BOX two miles south of Santiago in the Dominican Republic. He stated that this was the first record of this species of *Tiphia* occurring outside of the United States. In 1912, 1913, and 1914, G. N. WALCOTT, while working for the Porto Rican government, collected a number of *Tiphia* cocoons from various parts of the United States. Most of the adults emerging from these cocoons were used in cage experiments but from a lot of material that was collected in the autumn of 1914, 79 per cent of the emerging adults were liberated in cane fields in Porto Rico. Since the liberation of these adults no specimens of any American species of *Tiphia* have been reported from the island of Porto Rico and it is surprising to find an American species in the Dominican Republic now.

CHAS. T. GREENE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. HENRIK LUNDEGÅRDH, Director of the Ecological Station, at Torekov, Sweden, recently gave at the Department of Agriculture an illustrated account of investigations in plant ecology conducted on the island where his station is located.

A Bibliography of Bibliographies on Chemistry and Chemical Technology, 1900–1924, by CLARENCE J. WEST and D. D. BEROLZEIMER, is announced by the National Research Council, Washington, D. C., as their Bulletin No. 50 (308 p., $2.50). This work is composed of the following sections: General Bibliographies, Abstract Journals and Year-Books, General Indexes of Serials, Bibliographies of Special Subjects, and Personal Bibliographies. As the title indicates, the work is a compilation of bibliographies published as separates, or at the end of books or magazine articles, or as footnotes to the same, on the numerous aspects of pure and applied chemistry. Each entry gives name of author or compiler, title, and place of publication and most of them state the number of references. An approximate analysis shows that there are about 2400 subject headings, 7500 author entries and a total of 10,000 individual bibliographies.

The seventh annual meeting of the American Geophysical Union and of its sections will be held April 29 and 30, 1926, in the Building of the National Academy of Sciences and the National Research Council at 21st and B Streets, Northwest, Washington, D. C., with the exception noted in the schedule. The schedule of meetings is as follows:

April 29—9:30 a.m. to 12:30 p.m., Section of Geodesy; 2:30 p.m. to 5:30 p.m., Sections of Volcanology and Oceanography; 8:00 p.m. to 11:00 p.m., Section of Terrestrial Magnetism and Electricity (in the assembly room of the Administration Building, Carnegie Institution of Washington, 16th and P Streets, Northwest).

April 30—9:30 a.m. to 12:30 p.m., Sections of Meteorology and Seismology; 2:30 p.m. to 5:30 p.m., general meeting of the Union.

The Petrologists' Club met at the home of H. G. FERGUSON on February 2. *Program:* B. S. BUTLER: *Some features of the tops of Keeweenawan lava flows;* N. L. BOWEN: *Crystalline compounds in the lime-soda silica system;* H. S. WASHINGTON: *Italite from the Alban Hills.*

The Pick and Hammer Club met at the Geological Survey on January 23, to hear reports on the geological papers presented at the Kansas City meeting of the American Association for the Advancement of Science, and the New Haven meeting of the Geological Society of America.

Dr. L. H. DEWEY, chief of the Office of Fiber Investigations, Bureau of Plant Industry, has gone to Porto Rico for two months of field work.

Dr. JANET PERKINS, an American botanist long resident in Berlin, author of numerous works in systematic botany, is visiting Washington. She is studying collections at the National Herbarium.

PETER KLAPHAAK, assistant pathologist in the Office of Sugar investigations, Bureau of Plant Industry, died December 14, 1925, of pneumonia. Mr. Klaphaak was born and educated in Holland, and did post-graduate work at the University of Michigan. He had been working on the mosaic disease of sugar cane in the Department of Agriculture for the last few years.